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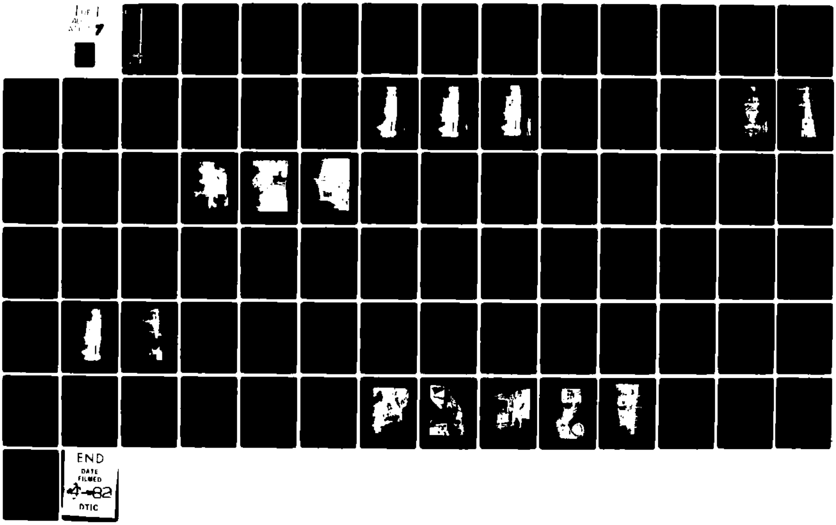

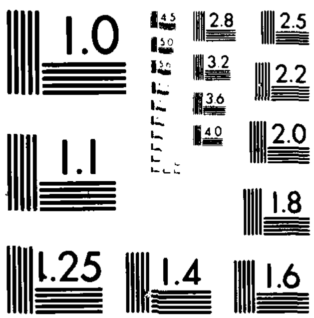

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Report 2337

MODULAR DISTRIBUTION SYSTEMS MODEL MDS-16 20-TON TRANSFER FRAME SYSTEM AND MDS-43 GANTRY FRAME SYSTEM

by

Eugene J. Rodrick

September 1981

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U.S. ARMY MOBILITY EQUIPMENT
RESEARCH AND DEVELOPMENT COMMAND
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The MDS-16 Transfer Frame System and MDS 43 Gantry Frame System were tested and evaluated to determine if they had the potential for satisfying a need for a lightweight, low-volume container handler and a hoisting device for building up air-drop platform loads in forward areas. The results of the testing were satisfactory but some modifications to the equipment would be required to facilitate use in a military environment.

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PREFACE

This report summarizes the effort conducted under Military Adaption of Commercial Items (MACI) Project No. E783468(5398), "Container Systems in Field Environment," by the US Army Mobility Equipment Research and Development Command (MERADCOM) on the MDS-16 20-Ton Transfer Frame System and MDS-43 Gantry Frame System as potential solutions to providing a lightweight container-handling capability for forward unit application.

The results of technical and user testing and evaluation to verify manufacturers claims and evaluate the equipment under several scenarios are contained in this report.

The report concludes that the equipment meets the manufacturer's claims but would require some modifications to facilitate use in a military environment.

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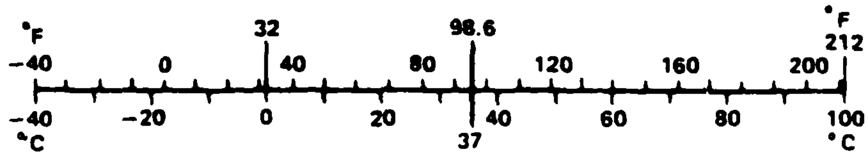
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	metric ton	t
		VOLUME		
tsp	teaspoons	5	milliliters	mL
Tbsp	tablespoons	15	milliliters	mL
in^3	cubic inches	16	milliliters	mL
fl oz	fluid ounces	30	milliliters	mL
c	cups	0.24	liters	L
pt	pints	0.47	liters	L
qt	quarts	0.95	liters	L
gal	gallons	3.8	liters	L
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	degrees Fahrenheit	5/9 (after subtracting 32)	degrees Celsius	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
AREA				
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10 000 m^2)	2.5	acres	
MASS (weight)				
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	metric ton (1000 kg)	1.1	short tons	
VOLUME				
mL	milliliters	0.03	fluid ounces	fl oz
mL	milliliters	0.06	cubic inches	in^3
L	liters	2.1	pints	pt
L	liters	1.06	quarts	qt
L	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
TEMPERATURE (exact)				
°C	degrees Celsius	9/5 (then add 32)	degrees Fahrenheit	°F

MODULAR DISTRIBUTION SYSTEMS MODEL MDS-16 20-TON TRANSFER FRAME SYSTEM AND MDS-43 GANTRY FRAME SYSTEM

I. INTRODUCTION

1. Background.

a. The purpose of this report is to summarize the development effort conducted by the Mobility Equipment Research and Development Command (MERADCOM) in evaluating Modular Distribution Systems (MDS) Model MDS-16 20-Ton Transfer Frame System and MDS-43 Gantry Frame System as potential solutions to providing a lightweight container-handling capability for forward unit application. This report covers the results of technical and user testing conducted to verify manufacturer's claims and evaluate the equipment under several scenarios.

b. In December 1976, a Draft Letter of Agreement (DLOA), titled "Lightweight Container Handler (LWCH) for 20-40 ft ANSI/ISO Containers," was prepared at the Missile and Munitions Center and School (M&MCS). This DLOA described the need for lightweight container-handling equipment to be used in forward areas for transferring cargo containers from line haul transportation to ground storage areas and vice versa. The LWCH would have a low production rate but would be light in weight compared to existing container handlers, less costly, and easily transported.

c. The Foreign Science and Technology Center (FSTC), Charlottesville, Virginia became aware during 1977 of a Transfer Frame being produced by MDS Ltd., Peterborough, England. This information was provided the Project Manager Army Container Oriented Distribution Systems (PM-ACODS), and arrangements were made to demonstrate the system during the Joint Logistics Over The Shore (JLOTS) test in August 1977.

d. The PM-ACODS on 26 January 1978 requested MERADCOM toprocure and evaluate two systems, the MDS-16 Transfer Frame System and MDS-43 Gantry Frame System, produced by MDS Ltd., Peterborough, England. The MDS-16 was to be evaluated to see if it had the potential for meeting the requirements of the DLOA, and the MDS-43 was to be evaluated to see if its ability met requirements of the XVIII Airborne Corps expressed in their letter to the PM-ACODS, dated 9 February 1978, which saw this system as having the potential to serve as a hoisting device for configuring air-drop platforms at an Intermediate Staging Base (ISB).

e. The MDS-16 Transfer Frame System was also evaluated favorably by the British Army and reported in their Trial Report No. 233, "Evaluation of MDS Ltd. Transfer System," dated March 1978.

f. Under Military Adaptation of Commercial Items (MACI) Project No. E783468(5398), "Container Systems in Field Environment," a $96,000 contract was awarded to MDS Ltd., on 21 September 1978 for two MDS-16 Transfer Frame Systems; one MDS-43 Gantry Frame System; repair parts; manuals; and diagnostic equipment to be used for test and evaluation of their military potential.

g. The hardware was delivered to MERADCOM on 26 April 1979. During the period from April 1979 to May 1980 the equipment was subjected to a series of technical and user evaluations. The technical evaluation was conducted at MERADCOM's North Annex proving ground at Fort Belvoir, Virginia, and user evaluations were conducted by the XVIII Airborne Corps at Fort Bragg, North Carolina and the Human Engineering Laboratory at Aberdeen Proving Ground, Maryland.

II. INVESTIGATION

2. Description of Material.

a. MDS-16 ISO Container Transfer Frame Handling System.

(1) The MDS-16 consists of:

- Four lift posts.
- Four free-standing stools.
- One control cabinet.

(2) The MDS-16 Container Transfer System is a simple and safe method of lifting fully loaded ISO containers weighing up to 20 LT on and off line haul vehicles for ground-level loading and unloading.

It comprises four independent, free-standing lift posts, each housing a hydraulic cylinder. Each lift post is fitted with forklift pockets so that it can be picked up by any standard 4,000-lb forklift truck, carried to and positioned on the container. It is possible to adjust the lift post to suit any ISO container height from 8 ft to 9 ft 6 in. to 6-in. increments.

The lift posts are locked to the container through its standard top and bottom corner casting and a bell and flashing light warn if the locks are not properly engaged.

Power for the lift posts comes from a separate central control cabinet, which is linked to each lift post by means of a multicore cable.

Movement is controlled by a hand-held console which is fitted with one automatic button, four trim adjuster buttons, an UP-direction button, and a DOWN-direction button. The master automatic button moves all four lift posts in unison either up or down according to the direction button selected, and the other four trim adjuster buttons each control one lift post.

Movement occurs only when a movement button and a direction button are being depressed. The lift posts otherwise stand locked where they are until the buttons are depressed again.

The independent control of each lift post enables the container to be kept level even when it is standing on uneven ground or its load is displaced. To assist in this, a buzzer sounds if the container moves laterally more than 2° out of horizontal.

Figure 1 shows the operating sequence of the MDS-16.

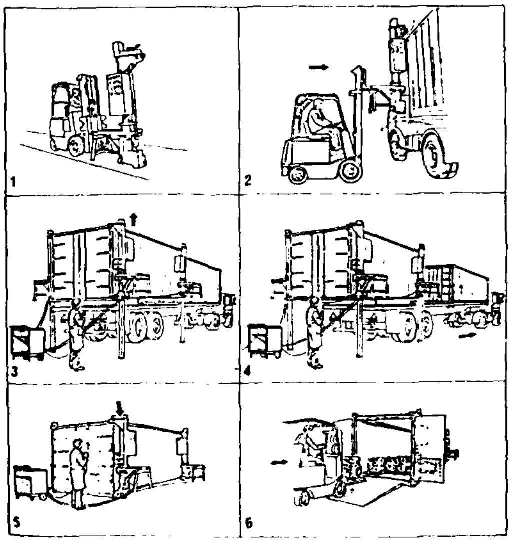
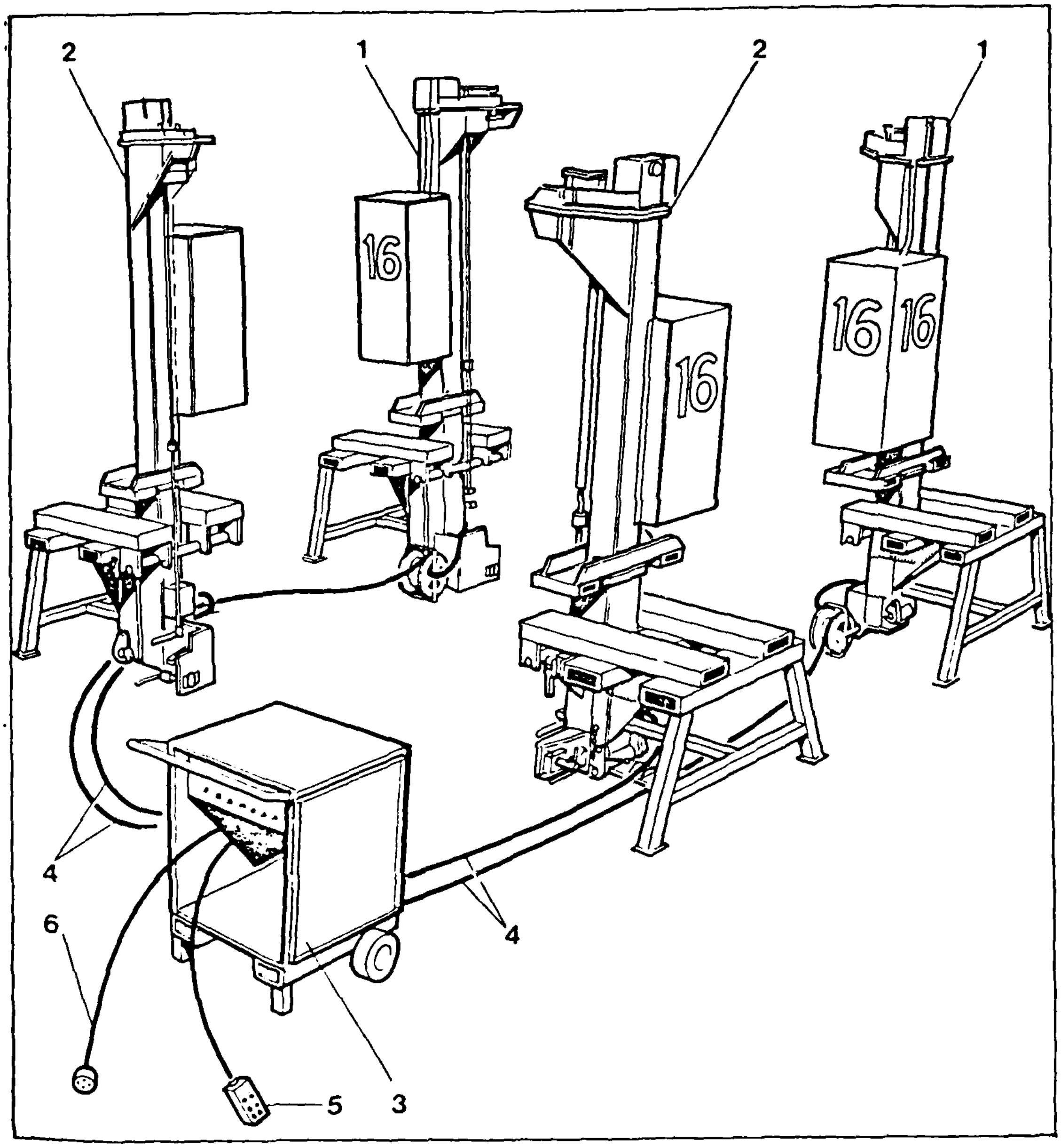


Figure 1. Operating sequence.

(3) Key Components (see Figure 2).



1 – One pair front-lift posts (height adjustment 8 ft/2.43 m to 9 ft 6 in./2.89 m)
2 – One pair rear-lift posts (height adjustment 8 ft/2.43 m to 9 ft 6 in./2.89 m)
3 – One central control cabinet
4 – Cable and plug connection to each lift post
5 – Control console with lead
6 – Electric power mains connection cable with plug

Figure 2. Key components.

- **Lift Posts.** There are four, independent, telescopic lift posts with guides and locks which locate and secure them to the eight corner castings of an ISO container. Each lift post is built to mount only in its designated position.

- **Central Control Cabinet.** There is one small, mobile, central control cabinet which is positioned at the rear or side of the container. This receives incoming electric power and, through a master control unit, distributes power and control signals to the four lift posts.

- **Control Console.** There is a hand-held control console which is connected to the central control cabinet and provides the operator with fingertip control from any suitable vantage point. All control, warning, and light circuits operate at 24-volt d.c.

- **Cables.** There are four multicore cables with single plug connections which connect the lift posts to the central control cabinet. The two front lift posts have cable reeling and tensioning drums which, in combination with cable grips on the two rear lift posts, keep the cables taut.

(4) Main Features of Lift Posts.

- **Twist Locks** – The twist locks secure each lift post to the container. The levers which operate the twist locks are situated in the lower outer lift post area. When the levers are in the locked position they register on limit switches which actuate the safety circuit.

- **Lift Cylinder** – The main lift cylinder is anchored by horizontal trunnions to the upper end of the lift post and to the lower end of the telescopic post. The lift cylinder provides the lift force only. Vertical stability is maintained by the lift post itself, the base of which transmits the thrust to the ground.

- **Telescopic Outer Sleeve** – Height adjustment is achieved through the sliding outer sleeve which can be anchored by a plunger lock at any of the standard ISO container heights. This sleeve carries the bottom twist lock and also the combined support stool and forklift pockets.

- **Lift Stools** – The lift stool with its forklift pockets under normal conditions remains locked to the sleeve. If it is necessary for a container to be placed within 24 in. of a wall, the lift stools are removed after the lift posts have been locked to the container.

- **Electro-hydraulic Power Pack** – An integral electro-hydraulic power pack is mounted vertically on the side of the lift post. This operates in closed circuit with the lift cylinder through incorporated control valves.

- **Light** – A flashing warning light illuminates as soon as the motor is running.

- **Socket** – All power and control circuits are centralized in one weatherproof multi-pin socket.

(5) The physical characteristics of the MDS-16 are shown in Table 1.

(6) Photographs of the MDS 16 are shown in Figures 3, 4, and 5.

b. **MDS 43 – Gantry Frame Handling System.**

(1) The MDS 43 consists of:

- One Main Beam Subassembly.
- Two End Frame Subassemblies.
- Two Tie Frame Subassemblies.
- One MDS 16 Transfer Frame System.

(2) The MDS 43 Gantry Frame Handling System is a fabricated lift beam structure having main end frames which are dimensionally and structurally equivalent to the standard ends of an 8-ft by 8-ft ISO container including the ISO corner casting connections.

The End Frames and the Main Lift Beam are securely braced and gussetted, for strength and stability, to provide an integral structure.

The Main Beam is provided with one central lift point and two side positions which provide lift positions to coincide with a standard 8-ft vehicle width.

The Gantry Frame System comprises 5 prefabricated subassemblies and is designed for a safe working load of 20 tons (see Figure 6):

Table 1. Physical Characteristics of the MDS-16

Features	Function	Limit or Rate
Lift capacities:	Nominal load	20 tons
	Maximum safe even load	22.5 tons
	Maximum safe working load per post	4.5 tons
	Safety factor	1.2
	Surge valve locks engage when descent speed reaches	2.88 ft/s
	Maximum lift capacity per post	7.6 tons
	Test load	22.5 tons
Engagement locks:	Incremental settings enable twist-locks to be engaged on standard ISO containers	8 ft 0 in., 8 ft 6 in., 9 ft 0 in., 9 ft 6 in. container corner heights
	Length – width	Any standard length or width of ISO container
Electrical supply:	Input to overall system	250/440 V 3-phase 60 Hz 1.5 kW
	Hydraulic pump motors	250/440 V 3-phase 5.6/3.2 amp 60 Hz 3410 r/min
	Control and warning systems	24 V d.c.
Transfer post dimensions:	Width per post	28.5 in.
	Depth per post	24.125 in.
	Height per post (closed)	108.5 in.
	Maximum height per post raised to the 9 ft 6 in. position	196 in.
	Weight per post with stool	1400 lb
	Width per post with stool	34.625 in.
	Depth per post with stool	46. 25 in.
Projection:	Either side of ISO container:	
	Transfer post with stool attached	38 in.

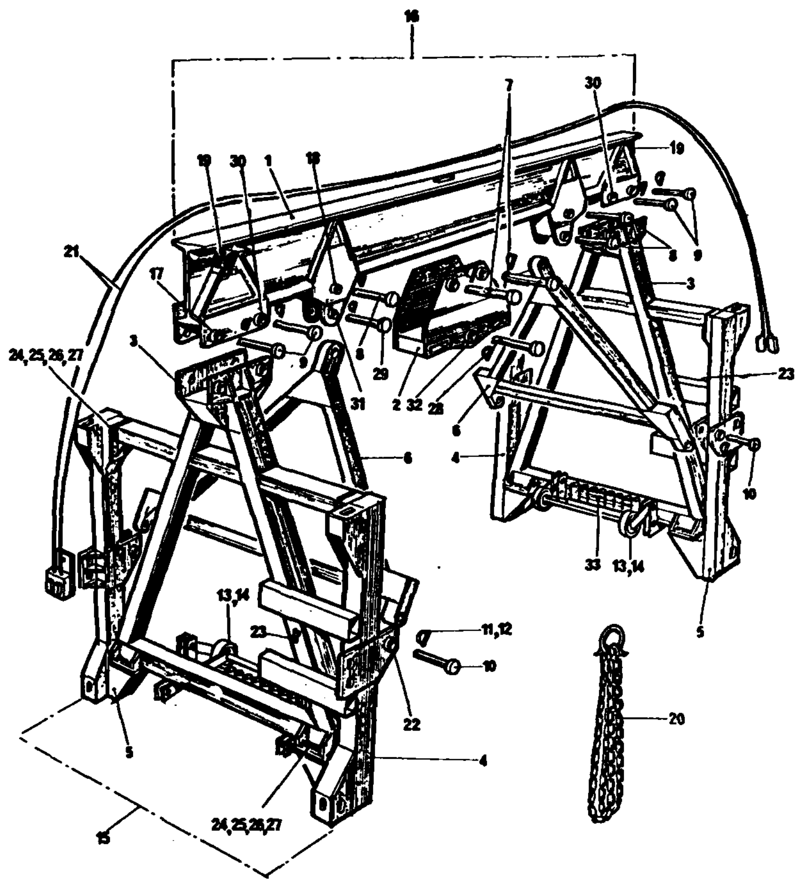
Table 1. Physical Characteristics of the MDS-16. (Cont'd)

Features	Function	Limit or Rate
	Transfer post only at hook	18 in.
	Total width with stools and 8 ft wide container	171.25 in.
	Maximum lateral span between legs when mounted on 8 ft wide container	108.75 in.
Lift speed:	Container weight	45,000 lb gross
	Ascending	3.69 ft/min
	Descending	6.42 ft/min
	Container weight	4000 lb (empty)
	Ascending	3.95 ft/min
	Descending	4.99 ft/min
Withdrawal and re-entry height:	Ground to underside of container:	
	Maximum distance (8 ft container height)	87.6 in.
	Maximum distance (9 ft 6 in. container height)	69.0 in.
Lift post foot dimensions:	Standard post feet	Length 6 in. Width 6 in.
	Spreader plates	Length 18.625 in. Width 15 in.
Ground loading imposed by lift posts:	At max SWL of	22.5 tons
	Standard post feet	312.50 $lb/in.^2$
	Spreader plates	40.27 $lb/in.^2$

Figure 3. MDS-16 positioned on grounded container.

Figure 4. MDS-16 raised to allow transfer of container to trailer.

Figure 5. Placement of container on trailer using MDS-16.



1. Main beam
2. Centre lift bracket
3. End frame
4. Right hand support leg
5. Left hand support leg
6. Tie frame subassembly
7. Centre pivot pin
8. Tie bar pin
9. Top pivot pin
10. Bottom pivot pin
11. Lynch pin
12. Washer
13. Wheel subassembly
14. Spring pin 1½ in. by 3/16 in.
15. Fitted end frame subassembly
16. Fitted main beam subassembly
17. Outer top pivot pin location
18. Top tie frame location
19. *Cable top fixing location*
20. Lift chain subassembly
21. Inter-connecting cable
22. Bottom tie frame location
23. *Cable side fixing location*
24. Bolt M12 by 40 Hex hd bolt
25. Nut M12
26. Spring washer M12
27. Plain washer M12
28. Centre chain location pivot pin
29. Side chain location pivot pin
30. Inter top pivot pin location
31. Lift chain side location
32. Lift chain centre location
33. Rack for spare pivot pins

Figure 6. Components of the MDS-43.

- The Main Beam Subassembly incorporating a central lift bracket section which is fitted with fork pockets for assembly by standard or rough terrain fork trucks.

- Two End Frame Subassemblies each incorporating top and bottom twist lock housings set at standard ISO container centers 8 ft by 8 ft for interconnection, locking and powered movement by the MDS-16 Transfer Frame System. Raising and lowering of the load is accomplished in the same manner previously described for the use of the MDS-16.

- Two Tie Frame Subassemblies.

The above subassemblies are interconnected and locked into position by fourteen 3-in. diameter pins fitted with spring pin locks.

(3) The Physical Characteristics of the MDS 43 are shown in Table 2.

(4) Photographs of the MDS 43 are shown in Figures 7 and 8.

3. **Tests and Test Results.** The objectives of the tests conducted on the MDS-16 and MDS-43 were to evaluate the technical characteristics of the systems against the manufacturers literature and specifications and conduct user evaluations to determine the system's potential in satisfying user needs in the forward area grounding of ISO containers and reconfiguring airdrop platforms at airborne ISB's. The testing program was conducted from April 1979 to May 1980 with the technical evaluation taking place at the MERADCOM Test Area, Fort Belvoir, Virginia and user evaluation being conducted by the XVIII Airborne Corps, Fort Bragg, North Carolina and the HELFAST Team of the Human Engineering Laboratory, Aberdeen Proving Grounds, Maryland.

a. **Technical Evaluation.**

(1) During the technical evaluation the following areas were investigated:

- Verification of technical characteristics.
- Safety and human factors.
- Level of skill required to assemble and operate.
- Length of time required to make system operational.

Table 2. Physical Characteristics of the MDS-43

Feature	Function	Limit or Rate
Lift capacity:	Total SWL on beam	20 tons
Dimensions:	Total height lowered	145.6 in.
	Maximum entry height lowered	117 in.
	Maximum entry height raised	204 in.
	Maximum entry width	185.0 in.
	Maximum depth w/o lift posts	96.0 in.
	Maximum depth with lift posts	174.0 in.
Weight:	Gantry without lift posts	6750 lb
	Gantry with lift posts	12,760 lb
	Gantry with lift posts and dollys	13,340 lb

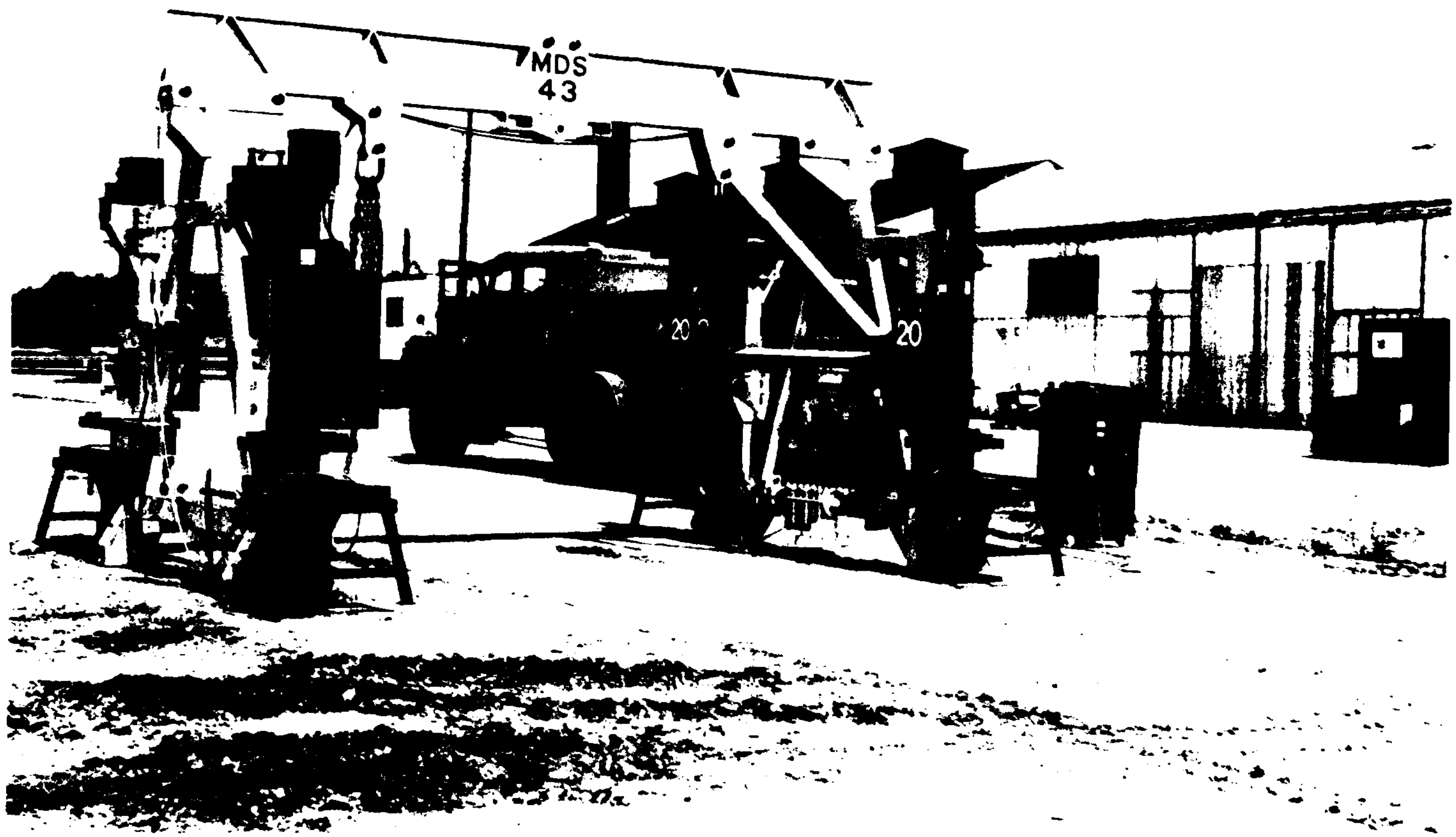


Figure 7. General view of MDS-43.

Figure 8. MDS-43 lifting an M113.

- Cycle time to transfer ISO containers.
- Transfer of equipment using the MDS 43.
- Free span of the MDS-16 when mounted on an ISO container.
- Removal of ISO containers from rail cars.
- Operation on various types of terrain.
- Maintenance requirements.
- Operator and maintenance manuals.

(2) The results of this evaluation are contained in the Product Assurance and Testing Directorate Test Report titled "Modular Distribution Systems Models MDS-16, 20-Ton Transfer Frame System and MDS-43, Gantry Crane," dated 2 June 1980 (Appendix A).

b. **User Evaluations.**

(1) **XVIII Airborne Corps, Fort Bragg, North Carolina.** The evaluation by the XVIII Airborne Corps was conducted in three phases:

(a) **Phase I – Aerial delivery.**

- The objective of this phase was to determine if the MDS-43 Gantry Frame System could enhance the Corps capability to rig equipment and supplies in a field environment with primary emphasis on heavy drop rigging of engineer items and the M551A1 Sheridan.

- During the evaluation the MDS-43 was successfully used to rig the following loads:

Item	Rigged Weight (lb)
M151 – ¼-ton truck	3,088
Case 1150 – Bulldozer	25,130
M561 – 1¼-ton truck	8,920
645M – Scoop loader	29,650
M551 – ARAAV	35,100

- Detailed results of this evaluation are presented in the letter report titled "Evaluation Report of Gantry Crane System (MDS-43), Aerial Delivery Phase," 22 August 1979, prepared by the 612th Quartermaster Company (Air Delivery) (Appendix B).

(b) Phase II – Maintenance – Direct Support/General Support (DS/GS).

- The objective of this phase was to determine if the MDS-43 could enhance the DS/GS maintenance capability of the 1st Corps Support Command by freeing wreckers and cranes, now used to lift engines and other heavy items, for recovery of disabled vehicles and equipment, and provide a lift capability in both the field and garrison which the units do not have at present.

- It was determined that the MDS-43 could perform the lifting tasks required but because of its inability to provide for lateral movement it could not be effectively utilized for tasks such as the removal of engines or the removal and replacement of gun tubes which requires 17 feet of lateral movement for the largest guns.

(c) Phase III – Terminal transfer (container operations).

- In this phase the objective was to utilize the MDS-16 Transfer Frame System for the mounting and dismounting of 20-ton capacity cargo containers onto or from container transporters in both the garrison and field environment.

- A very limited evaluation was conducted during this phase since there was no perceived mission within the Corps to handle cargo containers. One container was successfully loaded onto a transporter in garrison and removed at a field location using the MDS-16.

(2) HELFAST Team of the Human Engineering Laboratory, Aberdeen Proving Ground, Maryland.

(a) The objective of this evaluation was to test the MDS-16 in its container handling mode to mount and dismount containers from transport vehicles in an ammunition supply point (ASP) type environment and to evaluate the human factor aspect of the MDS-16 hardware. Presently, there is no such capability in the TO&E of the ASP's ammunition company and the anticipated frequency of need does not justify inclusion of more costly container handling equipment.

(b) The conclusions reached during this test were that the MDS-16 performed well in each test conducted, with no malfunctions and with completely satisfactory results. The system appears to be well suited for low volume container grounding or mounting. It is flexible enough to accommodate reasonable uneven ground (i.e. misalignment of semi-trailer or carrier in any direction up to at least 6 inches) and can withstand safely a minor collision with the supporting legs. The system appears to be suitable for military adoption although logistical support requirements would be simpler with military standard electrical connectors and SAE hardware.

(c) Detailed findings of this evaluation are contained in the US Army Human Engineering Laboratory Letter Report Number 280, June 1980, titled "MILVAN Jacking System Test conducted at the HELFAST Field Test Site" (Appendix C)

(d) Photographs of the MDS-16 during the HELFAST test are shown in Figures 9, 10, and 11.

III. DISCUSSION

4. **Date and Source of Purchased Equipment.** On 21 September 1978, two MDS-16 Transfer Frame Systems and one MDS-43 Gantry Frame System with system diagnostic equipment, repair parts, operator and maintenance manuals were purchased from MDS, Ltd., for test and evaluation.

5. **Previous Results of Tests on Equipment.** The MDS-16 had been evaluated previously by the Materials Handling Trials Unit, Royal Army Ordnance Corps (RAOC), in March 1978 and favorably reported on in their Trial Report No. 233 titled "Evaluation of MDS LTD Transfer System." The Royal Army has since procured 40 units for their forces.

6. **Lightweight Container Handler (LWCH).** US Army interest in systems of the MDS-16 type is expressed in a draft LOA for an LWCH for 20- to 40-ft ANSI/ISO Containers which states that "The LWCH will be used to mount and dismount 20-foot to 40-foot containers from their chassis at any point within the overseas theater. The LWCH will primarily be used at those locations where only a few containers are handled. This could be at the transportation nodes and low-volume receiving points where the assignment and use of a 50,000-lb Rough Terrain Container Handler (RTCH) is not justified (less than 24 containers handled per day), or it could be used at locations where there is normally no requirement to handle containers to and from their chassis, such as along the road in the event of semi-trailer or chassis failure. The Containerized Shipment and Storage of Ammunition (COSSA) study, however, indicates a desirability of being able to ground fully loaded ammunition con-

Figure 9. Transferring MDS-16 lift post with RTFL.

Figure 10. Positioning MDS-16 lift post on MILVAN.

Figure 11. Securing MDS-16 lift post to MILVAN.

tainers at ASPs thus lowering container profile and visibility. Presently available Container Handling Equipment (CHE), because of bulk and weight, is not suitable for operations in forward areas. These areas require lightweight CHE which is easily transported, set up, and operated."

7. **Basis for Evaluation.** The MDS-43 was evaluated because of an interest expressed by the XVIII Airborne Corps to have an item of equipment which could serve as a hoisting device for configuring air drop platforms at an ISB.

8. **Potential for Satisfaction of LOA.** Evaluation of the MDS-16 Transfer Frame System showed that it had potential to satisfy the requirements expressed in the draft Letter of Agreement (LOA). The MDS-16 is a lightweight, low-cost item, with the capability of transferring containers weighing up to 20 long tons between the ground and a chassis.

a. The system, consisting of four lift posts with stools and a control console with electrical cable and wander lead, has a total weight of 6010 lb of which each post weighs 1400 lb and the control console 410 lb.

b. The cost of the MDS-16 system was $30,500 in 1978.

9. **Cyclic Rates of Operation.** During the evaluation conducted by the HELFAST Team the MDS-16 was operated at the following cyclic rates:

Unload from Chassis (min)		**Load onto Chassis (min)**	
Start	0:00	Start	0:00
Affix legs	10:00	Affix legs	10:00
Raise MILVAN	12:30	Raise MILVAN	12:00
Remove carrier	13:00	Position carrier	13:00
Lower MILVAN	14:00	Attach MILVAN	15:30
Affix to 2nd MILVAN	24:00	Remove 4 legs	25:00
Raise MILVAN	26:30	Affix legs	35:00
Remove carrier	27:30	Raise MILVAN	37:00
Lower MILVAN	28:30	Position carrier	38:00
		Attach MILVAN	40:30
		Remove 4 legs	50:00

On a sustained basis the system is capable of offloading containers from chassis at a rate of 4.21/h or 84.21 in a 20-h day and of reloading containers onto chassis at a rate of 2.4/h or 48 in a 20-h day.

10. Manuals. The manuals provided by the manufacturer were adequate for use in training operating personnel.

11. General. The system is simple to operate and durable in construction. Its modular construction simplified replacement of damaged components. The system remained in uncovered outside storage when not operational for more than a year with no adverse effect.

12. Deficiencies of Equipment. The primary deficiencies noted during the evaluation were:

a. Transportability.

(1) The units were designed to be utilized in a fixed site where once they were set up they could be moved, with little difficulty, with a forklift truck. In the military environment the system will be subjected to many moves and therefore makes its transportability an important feature.

(2) The lift posts were difficult to transport from site to site. They either had to be maintained in an upright position on their stools or laid on their sides, which involved the removal of the hydraulic reservoir breather cap and replacing it with a plug so that hydraulic fluid would not drain out during transport.

(3) The problem can be solved by providing racks onto which the posts can be secured in a horizontal position during transport and by installing check valves in the hydraulic system which will prevent spillage of hydraulic fluid.

(4) The manufacturer, on subsequent units, has provided check valves which does correct this deficiency. He has also designed a rack which would allow for ease of transporting the equipment from site to site.

b. Forklift Tyneways.

(1) The system evaluated was designed for use with forklift trucks having a capacity of 4,000 lb, as such, the forklift tyneway provided on the stools and posts are sized for this size machine. During the user evaluation it became evident that the 6,000-lb rough-terrain forklift (RTFL) was a more prominent member of most using units and, as such, its fork tynes were too wide to be accommodated by the tyneways provided. This deficiency was corrected by welding secondary tyneways to the stools thus allowing the 6,000-lb RTFL to easily handle the lift posts.

(2) Any further procurement of this system should require all system tyneways to be compatible with forklifts up to and including the 10,000-lb RTFL. This appears to create no difficulty within the design parameters for the system.

13. **Capability of Equipment.** Evaluation of the MDS-43 Gantry Frame System, consisting of a main beam assembly, two end frame assemblies, two tie beam assemblies and an MDS-16 Transfer Frame System, showed that the system was capable of lifting all loads rigged for air drop and Low Altitude Parachute Extraction System (LAPES) in the XVIII Airborne Corps.

a. The gantry, without the MDS-16 system, weighs 6,750 lb and can be assembled by a 4-man crew plus forklift and operator in less than 1 hour.

b. The cost of the MDS-43 system was $18,200 in 1978.

14. **Rigging Applications of Equipment.** During the evaluation conducted by the XVIII Airborne Corps at Fort Bragg, North Carolina, the MDS-43 was successfully used to rig the following loads:

Item	Rigged Weight (lb)
M151 – ¼-ton truck	3,088
Case 1150 – bulldozer	25,130
M561 – 1¼-ton truck	8,920
645M – scoop loader	29,650
M551 – ARAAV	35,100

15. **Use of Equipment in a Maintenance Environment.** As a field lifting device, the MDS-43 proved to be ineffective because of the inability of the system to provide for lateral movement. This could be overcome by the addition of multi-directional bogies but even with these the lifting capacity and size of the system are excessive for use in the maintenance environment.

16. **Effectiveness of Equipment.** Following are some general observations.

a. Both the MDS-16 Transfer Frame System and MDS-43 Gantry Frame System functioned effectively in the roles prescribed in the manufacturer's literature.

b. The systems, which are commercially available, were designed for use in a relatively static environment, i.e., once setup they remained in the same locale for extended periods of time.

c. The deficiencies uncovered during this evaluation were caused by the requirement to operate in a military environment which required frequent moves from site to site thus requiring greater transportability than required commercially.

d. Workable solutions to these deficiencies have been proposed by the manufacturer and with their incorporation into the design will make these systems useful tools in forward area movement of containers and the field rigging of air drop platforms.

IV. CONCLUSIONS

17. **Conclusions.** It is concluded that:

a. The MDS-16 Transfer Frame System is a lightweight, low cost, commercially available system suited for low volume grounding or mounting of 20-ton freight containers in forward areas.

b. Deficiencies noted during the evaluation can be easily corrected to allow the MDS-16 to function effectively in a military environment.

c. The MDS-43 Gantry Frame System was capable of lifting all loads rigged for air drop and LAPES in the XVIII Airborne Corps.

d. In its present configuration the MDS-43 is not suited for use in a field maintenance environment.

e. The MDS-16 has been procured by the United Kingdom (UK) and is a potential system for the RSI program.

APPENDIX A

PRODUCT ASSURANCE AND TESTING DIRECTORATE TEST REPORT

Purpose of Test: The purpose of this test was to evaluate the ISO Container Transfer Frame Handling System and Gantry Crane as related to operating characteristics when operated in a field environment, and to verify the overall physical dimensions.

Product Tested: Modular Distribution Systems model MDS-16, 20-Ton Transfer Frame System and MDS-43 Gantry Crane, consisting of:

a. 4 Lift Posts, 4 Free-standing Stools, and 1 Control Cabinet Serial No. 70021 w/console.

b. 4 Lift Posts, 4 Free-standing Stools, and 1 Control Cabinet Serial No. 70022 w/console.

c. Gantry Crane 18 ft x 8 ft 4 in. Serial No. 70009

Test Location: The tests were conducted at the MERADCOM Testing Area by the Projects and Field Branch, Environmental and Field Division, PA&T Directorate.

Test Conducted By: Messrs Harold P. Mullins, Lloyd R. Johnson, Robert L. Combs, James N. Green, Arthur L. Limerick, Frank V. Dungan; Equip Operators. Aubrey Thomas, Jr. and Howard W. Lawrence, Mech Engr Tech. The test was witnessed by Mr. P. Davidson, Mech Tech Div, Mech & Constr Equip Lab.

Date Test Completed: 13 June 1979.

Disposition of Test Items: All items tested were shipped to Fort Bragg, North Carolina.

Abstract: Some difficulty was encountered at the outset of the test in maintaining equal lowering speed between the four lift posts. It was determined that several of the fluid flow control valves were defective. The fluid flow control valves were replaced in all eight lift posts; this corrected the problem. Tests on the two systems were completed without any major deficiencies occurring. Operator personnel operated both systems without difficulty. Personnel operating the system considered both systems to be safe, and that normal safety precautions as outlined in the opera-

tors manual are sufficient. The MDS-16 and MDS-43 lacks means for transporting the systems components in mass from one site to another.

Procedure: Technical and operator personnel were briefed on the operation of the MDS-16 and MDS-43 Gantry Crane by the manufacturer's representative prior to tests. The assembly of the system was supervised by the manufacturer's representative. During tests the systems were operated as prescribed by the manufacturer's operating manual. A 20 ft x 8 ft x 8 ft ISO container was loaded to 45,000 lbs gross weight, a 20 ft x 8 ft x 8 ft and a 40 ft x 8 ft x 8 ft 6 in. empty ISO container were used during the vehicle to ground to vehicle tests.

A 4000-lb capacity forklift truck with carriage side shift capability was used throughout the test to transport and attach the transfer posts. A military 6000-lb capacity rough terrain forklift truck was used to assemble and transport the Gantry Crane to various test sites. All physical measurements were taken on a clean level concrete surface. Tests conducted to determine the time required to load and unload a container were initiated with components of the MDS-16 system and support equipment 25 ft from the container and the vehicle to be loaded and unloaded. The cycle was timed from the moment the operator started forward to pick up the first transfer post and terminated when all equipment was returned to the initial starting point.

Test Results:

A. **Verification of Technical Characteristics.** The performance and measurement data contained in the specification and data sheet (Annex 1) are the results of actual tests and measurements. Data pertaining to safe working load (SWL) and power requirements were verified by the manufacturers representative and/or by checking the components in question. Information such as material standards and safety factor of the system was obtained from the manufacturers specification and data sheet. The maximum load capacity of the lift posts was determined by adding weight to one end of the container until the lift posts would no longer raise the loaded end of the container. Several specification and data sheets were submitted by the manufacturer, none of which were developed solely for the system tested. (Annex 2).

B. **Safety and Human Factors.**

(1) **Safety.** No major safety hazards were noted during operation of the MDS-16 and MDS-43 systems that were not covered by the "Operating and Safe Working Handbook." The safety hazard warning systems incorporated in the MDS-16 and MDS-43 systems are considered adequate.

(2) **Human Factors**. No major problems were noted during the test. The Control Console is connected to the Central Control Cabinet by a multi-wire cable which allows the operator to move about and view all four lift posts during operation. The Central Control Cabinet is equipped with an audible and visual (flashing lights) warning system which alerts the operator to a malfunction, improper cable connection, faulty cable and over two percent lateral tilt of the container. The warning lights and audible signal are of sufficient intensity to alert the operator at the maximum length of the console to Central Control Cabinet inter-connecting cable.

C. **Level of Skill**. Test personnel had no problem operating and/or assembling the MDS-16 and MDS-43 systems. Operator personnel assigned to the test were journeymen equipment operators (WG-11) with twenty or more years experience. A motor vehicle operator (WG-8) with little or no experience operating materials handling equipment was assigned to the project as a means of determining the skill level required to operate the two systems. Because of the simplicity of the system, only minimal skill is required to operate it. The motor vehicle operator assigned to the test was able to install the lift posts, complete the cable connections to the Central Control Cabinet, start and check out the system and operate the test units without difficulty. Journeymen equipment operators had no problem operating the MDS system, since most have been involved in tests on similar type equipment. All test personnel were given a copy of the Operating and Safeworking handbook furnished by the manufacturer to review prior to operating the unit. Test personnel were given a briefing and demonstration on how to assemble and operate the MDS systems by the manufacturers representative. The total time to instruct operators was approximately one hour.

D. **Length of Time Required to Make Systems Operational**. The initial time required to make the MDS–16 system operational was approximately 4.0 h for three men. This included uncrating, installing the stools, checking the units for fluid level, removing pipe plug and installing breather cap on the hydraulic reservoir of each lift post. Once the aforementioned checks were completed, the lift posts were attached to container for operational checks. Using a 6000-lb capacity rough-terrain forklift to move the components, it took three men approximately 1.0 h to assemble the MDS-43 Gantry Crane.

E. **Cycle Time to Transfer ISO Containers.** The cycle time required to transfer a 20 ft x 8 ft x 8 ft ISO container from trailer to ground was found to be in the range of 30-35 minutes, and from ground to trailer in the range of 45-50 minutes depending upon the vehicle operators ability to place the trailer under the container within the systems 4-in. shift limit. The difference in time required to load and/or unload empty and loaded containers was considered insignificant. Tests conducted using a 40 ft x 8 ft x 8 ft 6 in. ISO container, required changing the lift post height from 8 ft to

8 ft 6 in., the change requiring two minutes to complete. Once the height of the lift posts was adjusted, the transfer time was within the range of the 20 x 8 x 8 ft ISO container.

F. **Transfer of Equipment Using the MDS-43.** With a 5-ton tractor and 25-ton lowbed trailer as the transporter, a D-6 tractor and an Armored Personnel Carrier were loaded and unloaded several times using the MDS-43 Gantry without difficulty. Both items weighed approximately 25,000 lb. The lifting attachments on the MDS-43 were considered sufficient; however, it was felt that the lifting attachments should be movable to eliminate the lateral angle of the chain slings. The items were loaded and unloaded in approximately 15-20 min (see attached photos and Annex 3).

G. **Free Span MDS-16 Mounted on ISO Container.** 108.75 in.

H. **Removal of ISO Containers from Rail Cars.** Based on the overall width of two sizes of milvan rail car (two- and four-container capacity) and the free span of the MDS-16 system, the system could not be used to unload ISO containers from rail cars and transfer them to the ground or to a trailer. The width of the two rail cars is 126 and 116 in. and the free span of the MDS-16 system is 108.75 in. The width of the rail car would prevent extending the legs of the lift posts past the bed of the rail car. The MDS-43 equipped with a 20-ft top attachment possibly could be used to remove 20-ft ISO containers from rail cars. The maximum free span of the MDS-43 is 185 in., and based on the above rail car widths of 126 and 116 in. the free span is sufficient. The bed height of the rail cars measured is 44 and 51½ in. above the cross ties and the maximum entry height of the MDS-43 is 206½ in. Using a container height of 114 in. and a rail car bed height of 51½ in. a combined height of 165½ in. is obtained. Since the maximum entry height of the MDS-43 Gantry is 206½ in., this allows room for the installation of a 20-ft container top attachment and still allows room for raising the container clear of the rail car. The area surrounding the tracks and the center of the tracks would have to be level with the top of rails; otherwise the rails would impede backing a vehicle under the raised container.

I. **Operation on Various Types of Terrain.** The MDS-16 and the MDS-43 were operated on concrete and a medium compacted clay-gravel surface without difficulty. Both systems were operated on a wet, slightly muddy, clay-gravel surface without excessive difficulty. The primary difficulty encountered in mud and/or loose soil was the container settling into the soil or mud, which placed the corner post openings below the soil surface preventing the operator from attaching the lift post without first clearing the soil away. No tests were conducted in sand, however it may be logically concluded that conditions in sand would be similar to loose soil or mud.

J. **Maintenance Requirements.**

(1) **Maintenance Procedures.** Maintenance procedures as recommended by the manufacturer were considered adequate. The manufacturer's recommended preventive maintenance is on a periodic basis, similar to the present DA system consisting of the following maintenance schedule:

a. Daily (preshift).

b. Weekly (50 h).

c. Monthly (200 h).

d. Semi Annual (1200 h).

e. Annual (2400 h).

Preventive maintenance and Lubrication Charts are shown in Annex 4.

(2) **Ease of Maintenance.** All components of MDS-16 and MDS-43 systems are accessible to personnel for maintenance.

(3) **Repair Parts.** The spare parts furnished by the manufacturer were considered sufficient to cover normal electrical and hydraulic system failures.

K. **Operator and Maintenance Manuals.** The operator and maintenance manuals were considered adequate. The manuals were written in clear, precise language, accompanied by graphic illustrations. Operating personnel had no problem reading and interpreting the information presented.

L. **Conclusions and Recommendations.**

Conclusions. Based on the test results and discussions with operating personnel it is concluded that the basic design characteristics of the MDS-16 and the MDS-43 have potential for military use in situations not requiring rapid handling of large quantities of ISO containers. It is the consensus of the test personnel that the MDS-43, Gantry Crane offers the most possibilities. It has the capability of loading and unloading small and medium size engineering equipment and when equipped with a top attachment it apparently could handle 20 ft ISO containers without difficulty. However, additional tests must be made to verify this. The Gantry Crane can be moved by forklift and/or trailer without being disassembled.

Recommendations. It is recommended that a study be conducted on the MDS-16 and MDS-43 to determine if the following is feasible:

(1) Installation of generator and control console on small trailer to enhance mobility.

(2) Design rack to hold lift posts while transporting system from site to site.

(3) The Gantry Crane as a 20-ft container handler.

(4) Improve design of the lift post stools to increase stability on uneven surfaces.

(5) Installation of a rugged type of cable connector; present connectors are considered too fragile.

MDS-16 TRANSFER FRAME

SPECIFICATIONS AND DATA SHEET

Lift Capacities:	Nominal load	20 tons
	Maximum safe even load	22.5 tons
	Maximum safe working load per post	4.5 tons
	Safety factor	1.2
	Surge valve locks engage when descent speed reaches	2.88 ft/s
	Maximum lift capacity per post	7.6 tons
	Test load	22.5 tons
Engagement Locks:	Incremental settings enable twist-locks to be engaged on standard ISO containers	7 ft 11 in., 8 ft 6 in., 9 ft 0 in., 9 ft 3 in., 9 ft 6 in. container corner heights
	Length – width	Any standard length or width of ISO container
Electrical Supply:	Input to overall system	250/440 V 3-phase 60 Hz 1.5 kW
	Hydraulic pump motors	250/440 V 3-phase 5.6/3.2 A 60 Hz 3410 rpm
	Control and warning systems	24 V d.c.
Transfer Post Dimensions:	Width per post	28.5 in.
	Depth per post	24.125 in.

	Height per post (closed)	108.5 in.
	Maximum height per post raised to the 9 ft 6 in. position	196 in.
	Weight per post with stool	1400 lb
	Width per post with stool	34.625 in.
	Depth per post with stool	46.25 in.
Projection:	Either side of ISO container:	
	Transfer post with stool attached	38 in.
	Transfer post only at hook	18 in.
	Total width with stools and 8 ft wide container	171.25 in.
	Maximum lateral span between legs when mounted on 8 ft wide container	108.75 in.
Lift Speed:	Container weight	45,000 lb/gross
	Ascending	3.69 ft/min
	Descending	6.42 ft/min
	Container weight	4000 lb (empty)
	Ascending	3.95 ft/min
	Descending	4.99 ft/min
Withdrawal and Re-Entry Height:	Ground to underside of container:	
	Maximum distance (8 ft container height)	87.6 in.

Maximum distance (9 ft 6 in. container height)	69.0 in.

Lift Post Foot Dimensions:

Standard post ft	Length 6 in., Width 6 in.
Spreader plates	Length 18.625 in. Width 15 in.

Ground Loading Imposed by Lift Posts:

At max SWL of	22.5 ton
Standard post ft	312.50 lb/in.^{2}
Spreader plates	40.27 lb/in.^{2}

MODULAR DISTRIBUTION SYSTEMS MANUFACTURERS DATA

SECTION 6

Lift Capacities:	Nominal load	22.5 tons	22860 kg
	Maximum safe even load	24.0 tons	24385 kg
	Maximum safe working load per post	6.0 tons	6096 kg
	Safety factor	1.25	
	Surge Valve locks engage when descent speed reaches	2.88 in./7.30 cm/s	
Engagement Locks:	Incremental settings enable twist-locks to be engaged on standard ISO containers	8 ft 0 in., 8 ft 6 in., 9 ft 0 in., 9 ft 6 in. high (2.438 m, 2.59 m, 2,743 m and 2.895 m high)	
		And any standard length or width of ISO container	
Electrical Supply:	Input	380/440 V, 3-phase 50 Hz 10 kVA	
	Output–motors only	380/440 V	
	Control and warning systems	24 V d.c.	
Transfer Post Dimensions:	Width per post	45 in.	1143 mm
	Depth per post	36 in.	914 mm
	Height per post (closed)	108 in.	2743 mm

	Height per post (with raised 9 ft 6 in. 2.895 M-high container)	196 in.	4978 mm
	Weight per post (complete)	1400 lb	635 kg
Projection	Either side of ISO container: Transfer post with stool attached	37.5 in.	952.5 mm
	Transfer post only	18 in.	457.2 mm
Forklift Capacity for Placing Lift Posts on Mounted Containers:	Minimum Requirements All Containers: 2000 lb/910 kg lift capacity at 20 in./508 mm centers 9 ft 0 in./2438 mm lift height		
Load Imposed at Lift Pockets During Lift and Carry by Fork Truck:	20 in./508 mm load center at face:	1426 lb	648 kg
	20 in./508 mm load center at side:	854 lb	388 kg
Ground Loading Imposed by Lift Posts at Maximum S.W.L.:	Standard post ft	416.5 lb/in.^{2} 29.28 kg/cm^2	
	Spreader plates	66.6 lb/in.^{2} 4.68 kg/cm^2	

Material Standards:

Fabricated Assemblies and R.H.S. Tubes:	Steel to B.S. 4360, grade 43A and B.S. 4360, grade 43C.
Load Bearing Twist-Locks and Pins:	Steel to B.S. 970-1972, grade 605M36
Control Shafts & Levers	Steel to B.S. 970-1972, grade 070M20
Hydraulic Hoses:	S.A.E. 100 R7

TECHNICAL DATA SHEET – MDS 16 MANUFACTURERS DATA

Lift Post:

Width	45 in.	1143 mm
Depth	36 in.	914 mm
Height (closed)	107.75 in.	2690 mm
Height (with raised 9 ft 6 in. high container)	193 in.	4800 mm
Weight (per lift post complete)	.625 ton	635 kg

Dimension Capacity of ISO Containers:

Height	96/114 in.	2500/ 2900 mm
Width	96 in.	2500 mm
Length – Any length up to	480 in.	12190 mm

Load Imposed at Lift Pockets During Free Lift by Fork Truck:

24 in./610 mm load center at face	1188 lb	539 kg
24 in./610 mm load center at side	712 lb	323 kg

Ground Loading Imposed by Lift Posts at Maximum S.W.L.:

Standard post feet	228.9 lb/in.^{2}	40.88 kg/ cm^2
Spreader plates	57.25 lb/in.^{2}	10.39 kg/ cm^2

Factors of Safety:

Factors of safety for all load bearing components are in accordance with requirements of British Insurance Industry's Association of Technical Committees which govern British Standards for Lifting Equipment.

Forklift Capacity for Placing Lift Posts on Mounted Containers:

Minimum Requirements 8 ft high containers	1500 lb/680 kg lift capacity at 20 in./508 mm centers 8 ft/2438 mm lift height
9 ft 6 in. high containers	1500 lb/680 kg lift capacity at 9 ft/2743 mm lift height

MDS-43 TRANSFER FRAME AND COMPONENTS

Specifications and Data Sheet

Lift Capacity:	Total SWL on beam	20 tons
Dimensions:	Total height lowered	145.6 in.
	Maximum entry height lowered	117.0 in.
	Maximum entry height raised	204.0 in.
	Maximum entry width	185.0 in.
	Maximum depth w/o lift posts	96.0 in.
	Maximum depth with lift posts	174.0 in.
Weight:	Gantry without lift posts	6750 lb
	Gantry with lift posts	12,760 lb
	Gantry with lift posts and dollys	13,340 lb

PREVENTIVE MAINTENANCE

When carrying out the following recommendations, reference should be made to the accompanying preventive maintenance chart and recommended lubricants chart.

Pre-Shift. The checks listed below should be carried out at the commencement of each shift or when you take over the equipment.

- Check correctness and reaction of operating function in relation to operating instructions.

- Check warning and safety systems to ensure correct functioning.

- Check cable, plugs and sockets, twist locks and all other locks to ensure they are free from damage and in correct working order.

- Check height change plunger is fully engaged.

Weekly (50 h). In addition to pre-shift inspection:

- Inspect plugs, sockets and cables to ensure good condition.

- Carry out lubrication chart instructions.

Monthly (200 h). Follow weekly program and additionally:

- Clean filter in hydraulic system and check oil level.

- Check the guide plates (6) on the height adjusting sleeve for clearance and adjust if necessary.

- Make sure the correct operating clearance is .062 in./1.6 mm between each face.

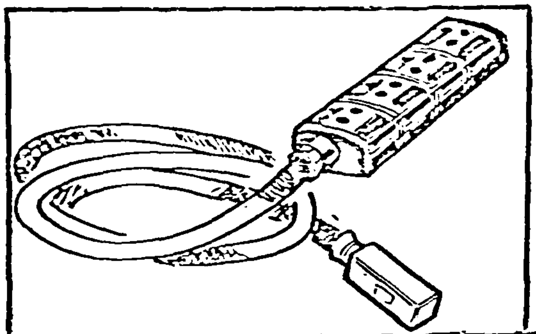
- Ease retaining bolts to light retention then tap to correct clearance and fully tighten bolts (see Page 44).

Half Yearly (1200 h). Follow all monthly schedules and additionally:

Change oil in hydraulic system.
Inspect total hydraulic system for oil leaks.
Inspect for wear and tear on twist locks and control mechanism.

Yearly (2400 h). Follow the half-yearly schedule.

Inspection Checks.

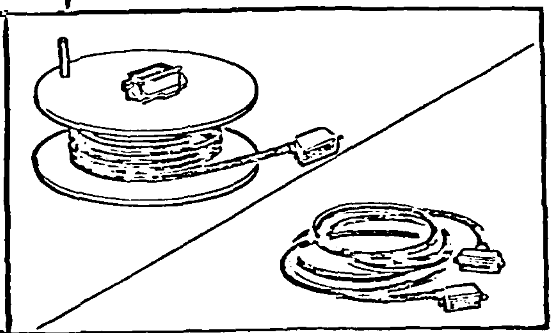


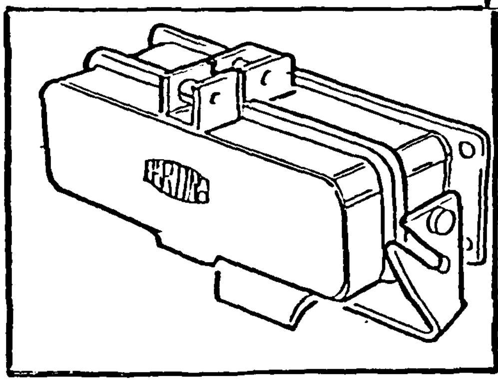
Cable Remote Control

Check plug cable and hand console for electrical safety, and soundness.

Cable Lift Post to Central Control Cabinet.

Check condition of outer covering. Check for soundness of cables and connections. Check 3-phase for electrical continuity and insulation.





Sockets and Plugs

Check condition generally.

Ensure that plug fits socket correctly and that clamp ensures plug into socket.

LUBRICATION OF LOCKS, SLEEVES AND OPERATING SHAFTS

Lubrication Chart.

1.	Height Change Plunger.	Fitted with grease nipple. Lubricated with grease gun every 250 h.
2.	Upper Twist Lock Shaft.	
3.	Bottom Twist Lock Shaft	Clean thoroughly and oil lightly as often as necessary to maintain free movement.
4.	Upper Twist Lock Control Shaft, Control Lever and Linkage	
5.	Telescopic Lift Posts.	Fully extend movement, then thoroughly clean and oil lightly as often as necessary to maintain free movement.
6.	Height Adjusting Sleeve.	
7.	Swing hooks for detachable stools.	No lubrication or other attention is necessary.

PREVENTIVE MAINTENANCE AND RECOMMENDED LUBRICANTS

Mechanical. Check twist locks frequently to ensure that no distortion or damage has taken place and that associated operating components are in good order. Also observe that other load bearing components are in good order.

Lubrication. Items 1 and 2 should be greased as necessary for free movement.

Item 3 should be regularly cleaned and oiled. S.A.E. 20 or 30 is sufficient to ensure easy movement.

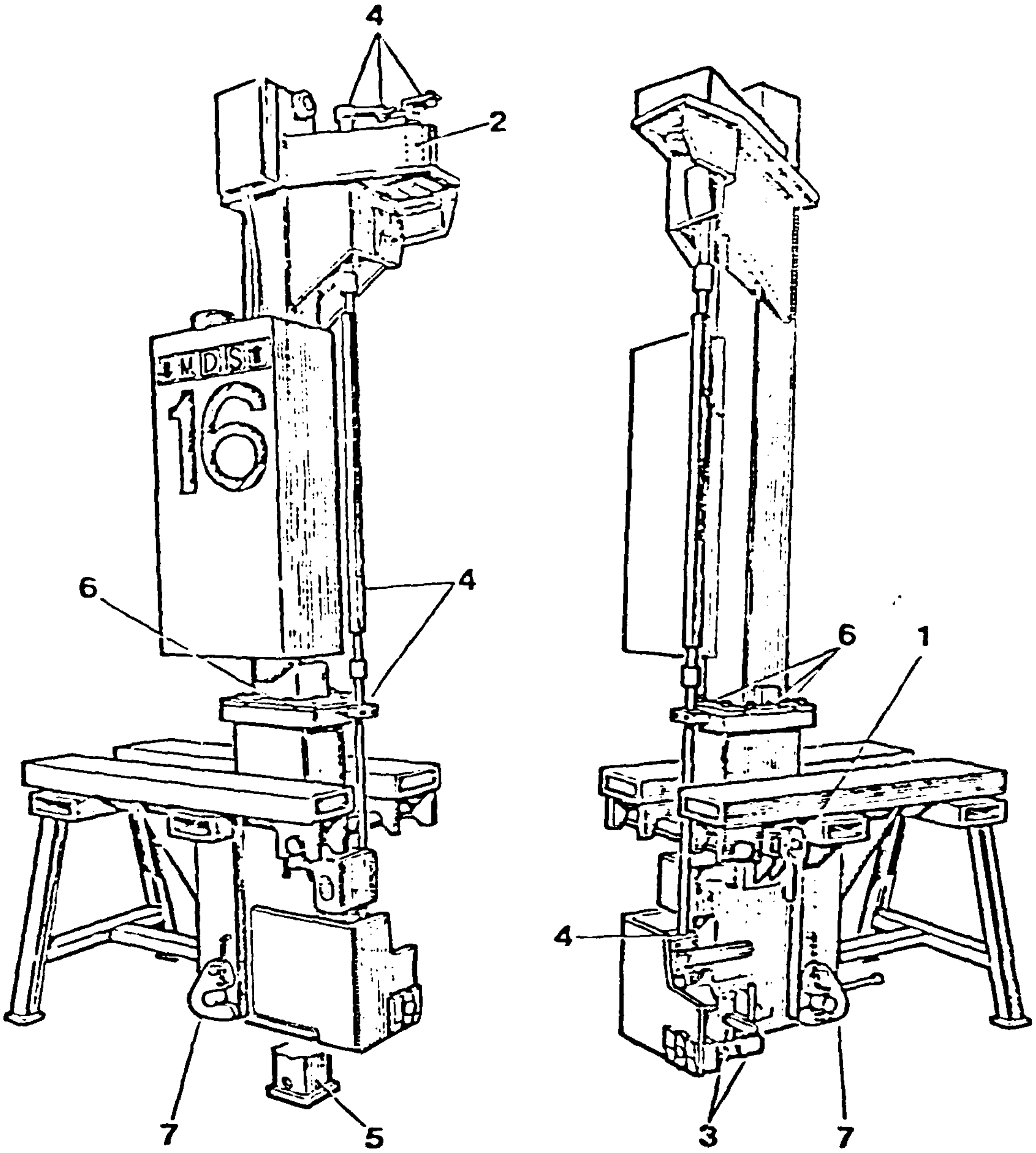
Items 4 and 6 require minimal lubrication with oil. S.A.E. 20 or 30 sufficient to ensure free movement.

Item 5 is lubricated on assembly and does not require regular attention.

Item 7 does not require lubrication.

Hydraulic. Check that oil level in each reservoir is full to ½ in. below the level plug. This should be checked when the post is fully retracted.

Important: This level should always be maintained. If spillage takes place the level should be corrected. Filler caps are fitted with micron air filters to prevent ingress of dust. It is imperative that the filters remain intact and that filler caps are fitted always.



MDS-16 Lubrication Points.

Oil within the reservoir must be clean and totally free from contamination of any type. Hydraulic hoses should be visually checked to ensure that they are undamaged.

Electrical. Provided it is handled and moved carefully, the control panel should operate without maintenance over long periods. The areas which require regular and close inspection are the plugs, sockets, cables, limit switches and lights. Visual inspection to ensure damage-free condition at frequent intervals is important.

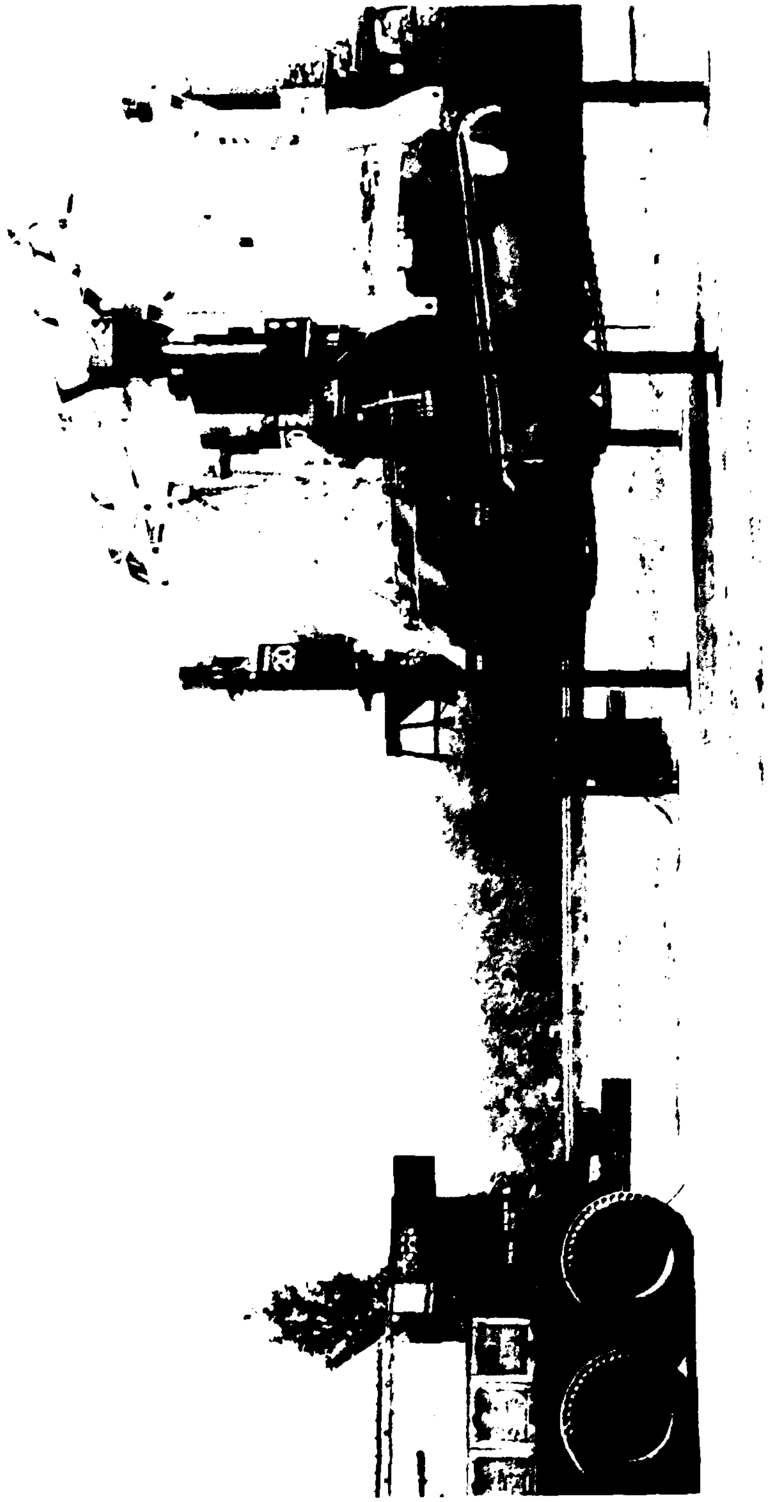
In the event of damage or weakness, repairs should be effected before further usage.

Recommended Hydraulic Oil.

Zone	Shell	Esso
Temperate	Tellus 29	Esso Automotive Transmission Fluid
Arctic	Tellus 23	Glide
Tropical	Tellus 41	NUTO H 32

Lubrications Points – (1) Use Standard Engine Oil; (2) Use Standard Grease.

MDS-16.



MDS-43.

APPENDIX B

DEPARTMENT OF THE ARMY
612TH QUARTERMASTER COMPANY (AIR DELIVERY)
FORT BRAGG, NORTH CAROLINA 28307

AFZA-AA-XDP-OPNS 22 August 1979

SUBJECT: Evaluation Report of Gantry Crane System (MDS-43), Aerial Delivery Phase

THRU: Commander
7th Transportation Battalion
ATTN: (S-3) (AFCA-AA-XDD)
Fort Bragg, North Carolina 28307

Commander
1st Corps Support Command
ATTN: SOTI (AFZA-AA-GBO)
Fort Bragg, North Carolina 28307

TO: Commander
18th ABN CORPS
ATTN: AFZA-GD-O
Fort Bragg, North Carolina 28307

1. **Reference Letter.** AFZA-GD-O dtd. 6 June 1979, Subject: Letter of Instruction (LOI), Evaluation of Gantry Frame Handling System (MDS-43).

2. **Background.**

A. Reference above directed evaluation of the MDS-43 Gantry Crane System in air drop rigging operations to determine it's suitability for possible incorporation into the TOE's of aerial delivery units assigned to XVIII Airborne Corps.

B. At present these units have no easily transported and assembled hoisting device for rigging operations at intermediate staging bases (ISB's).

3. **Description of System.** MDS-43 Gantry Crane System consists of a gantry frame, four MDS-16 lift legs, a control cabinet and an external power source as described below.

A. The gantry has a main lift beam and two end frames. The main beam is provided with one central lift point having a capacity of 40,000 pounds and two side lift points with a capacity of 20,000 pounds each. Either the center or the two side points may be used for lifting however, the individual load capacities must not be exceeded. Maximum capacity is 40,000 pounds. The end frames and main lift beam are braced and gussetted to provide integral stability and strength. The end frames are also equipped with attachment points for the four lifting posts described below.

B. The four telescopic lift posts are independent and free-standing, each using a hydraulic lift cylinder. Each post is fitted with forklift pockets to facilitate carrying to and positioning on the gantry. A lift point is also provided on top of each lift post for transporting and attaching with a crane type device. The lift posts are locked to the four corners of the end frames through top and bottom castings on the end frames. A bell and flashing light warn if the locks are not properly engaged.

C. The central control cabinet is linked to each lift post by means of a multicore cable. Movement is controlled by a handheld console which is fitted with one automatic button, four trim adjuster buttons, an "Up" direction button, and a "Down" direction button. The master automatic button moves all four lift posts in unison either up or down according to the direction button pressed. The other four trim adjuster buttons each control one lift post. The lift posts stand locked in position until both a movement button and a direction button are depressed.

D. The system does not include a standard power supply. For this evaluation a standard trailer-mounted, 60-kW generator set was used (NSN 6115-00-118-1243). Power supply must be capable of supplying 440 volts as this is the operating voltage of the system.

4. **Conduct of Evaluation.**

A. Training Phase–Eight personnel were trained on the MDS-43 system. This training was conducted by the commercial representative and covered a period of four days. This is considered the minimum time to adequately train a person on the system. Training consisted of an introduction to the equipment, it's capabilities and limitations, safety precautions and procedures, and assembly and disassembly. Practical work was conducted in assembly and disassembly. This training proved adequate to attain the level of proficiency required by personnel throughout the conduct of the evaluation. No maintenance was covered since the electrohydraulic system is too complicated for such an undertaking.

B. Rigging Phase – Six selected loads were rigged using the MDS-43 system. The system was evaluated for its ability to lift the unrigged load for placement on the air drop platform with energy dissipating material (honeycomb) and its ability to lift the fully rigged load to a trailer bed for transport to an airfield. A list of the loads and their dimensions is in inclosure 1.

(1) M151 ¼-ton truck. This is the only load evaluated which could be lifted utilizing the air drop suspension slings. Slings were attached to the center lift point and load was successfully lifted for both operations described above.

(2) Case 1150 Bulldozer. This load was successfully lifted with the adjustable chains which were supplied with the gantry system. Chains were attached to the air drop suspension points on the bulldozer and the two side lift points on the gantry. This item can be lifted with the air drop suspension slings installed.

(3) M561 1¼-ton truck (Gamma Goat). Successfully lifted with chains from suspension points on truck to side lift points on gantry. Can be done with air drop suspension slings installed. This load was also successfully lifted when rigged in a Low Altitude Parachute Extraction System (LAPES) configuration.

(4) 645M Scoop Loader. Could not be lifted with chains because they would have damaged the bucket and hydraulic lines. A sling system was rigged using 14-foot (11 ft and 3 ft) slings to the rear suspension points and 8-foot slings to the front suspension points. Slings were attached to the side lift points on the gantry. A 3-foot sling was used for attachment to each of the two lift points. The air drop suspension system cannot be installed on this load until it is on the trailer.

(5) M551 ARAAV. Could not be lifted with chains because of extreme angle diminishing strength of chains. Lifted with 9-foot slings to the rear suspension points and 11-foot slings to the front suspension points. Slings were attached to side lift points on the gantry. A 3-foot sling was used for attachment to each of the two lift points.

C. The evaluation was culminated by having the evaluation crew disassemble, load, transport to a new location, unload, and assemble the MDS-43 system. Those procedures were timed and the results are on inclosure 2. Assembly time was not stopped until the system was assembled, power connected, and the gantry raised to its full height.

5. **Discussion.**

A. There was only one breakdown of the system during the evaluation period. On 2 July the system broke down while suspending a ¼-ton truck in the raised position. A 10,000-pound rough-terrain forklift truck was used to remove the ¼-ton truck from the gantry. The civilian representative was out of town and returned on 5 July. On that day he again had the system operational by repairing two bad power cables, one bad console station, and one bad lift post motor.

B. The system requires a 440-volt power source which is not easily attainable in the United States and must be provided by a generator. The trailer-mounted generator used in this evaluation weighed 6,700 pounds and has a price tag of $20,365 (Power Unit PU 650B/G, NSN 6115-00-258-1622).

C. The system has no manual back-up system in the event of a power failure.

D. The dolly wheels with which the gantry is outfitted allows it to only traverse perpendicular to the rigging line (roller conveyors) and not parallel to it. Due to the weight of the system, mechanical assistance is required to move it with the dolly wheels.

E. Because the gantry cannot be traversed up and down the rigging line, two systems would be required for each line when engaged in assembly line rigging operations. One system would be placed at the inbound end of the line and used to place the load on the air drop platform. The second would be placed at the out-bound end of the rigging line and used to place the rigged load on a trailer for transport to the air field. Both systems could be powered by one generator however, it would necessitate running high voltage wires the length of the rigging line.

F. The only evaluation load which could be lifted utilizing the air drop suspension slings was the M151 ¼-ton truck. On all other loads the air drop suspension slings were too long to allow sufficient ground clearance. The remainder of the loads were lifted using either adjustable chains or assembling a second sling system for lifting purposes only.

G. The only loads which require a crane for transfer from trailer to K loader at the airfield are those which weigh in excess of 24,000 pounds. These are transported on "low-boys" and the K loader cannot get low enough to effect the transfer by pushing the load. In order for the MDS-43 to be used in this application it would be necessary for the K loader to be positioned directly beneath the suspended load. This is not possible since the width of the 40K loader is 156 inches and the clearance between the gantry legs is 118 inches.

H. The MDS-43 system can be air transported in the C-130 and C-141 aircraft with the following limitations:

(1) The lifting posts cannot be transported in a vertical position because of height (107 inches). They must be air lifted in a horizontal position by blocking and bracing on a 463L Air Force pallet of an 8-foot air drop platform. They must be loaded in two layers of two posts each. Valves must be installed to prevent leakage of hydraulic fluid while posts are horizontal.

(2) The gantry frame and control cabinet can be "rigged" for transport on a 20-foot air drop platform. This necessitates that an Air Force K loader be available at both the departure and arrival airfields.

(3) One entire C-130 would be required to airlift the MDS-43 system and power supply.

I. The MDS-43 system can be land transported on one 40-foot flat bed trailer. A 2½-ton cargo truck is also required to tow the trailer-mounted power supply.

J. Each of the lift posts is equipped with forklift pockets for hoisting onto the gantry frame. These pockets are too small to accommodate the forks of a rough terrain forklift truck. This problem was overcome by placing the forks under the pockets instead of in them. Each post is also equipped with a fitting on top so that it can be lifted and installed with a crane-type device. (A rough terrain forklift can also be used for this).

K. The two-point suspension afforded by the system minimizes sway and makes it much easier to position loads on the honeycomb stacks.

L. The lateral movement of the MDS-43 is limited to approximately 8 inches. This is sufficient to allow for precision placement of the load on the honeycomb stacks.

M. The MDS-43 was not used in rigging containers for the Container Delivery System (CDS). Because of the nature of the contents and the relatively lightweight of these loads (Max. 2,200 pounds) it is more feasible to rig and outload with a rough terrain forklift truck.

N. Approximately 120 seconds is required to lift the system to its maximum height.

6. Conclusions.

A. The MDS-43 Gantry Crane System is capable of lifting all loads rigged for air drop and LAPES in XVIII Airborne Corps.

B. Due to its size the system is better suited for use in rigging loads in the heavier weight ranges, such as engineer equipment, than for lighter items which would normally be rigged using the assembly line method.

C. A minimum of four days is required to train rigger personnel (MOS 43E) in the assembly and safe operation of the system. The system itself can be used as the training aid.

D. The manufacturer's publications are adequate to assemble and safely operate the system.

E. A four-man crew plus forklift and operator can assemble the system in less than one hour.

F. The system can be air transported in the Air Force C-130, C-141, and C-5A aircraft. Forty feet of cargo compartment space is required for the system and its power supply.

G. The system is too sophisticated to be maintained at user unit level.

H. No need exists to introduce the system into the area of operation by air drop mode.

I. The system is not capable of transferring rigged loads to K loaders. Loader is too wide to fit between gantry legs.

J. The system has no manual back-up system in the event of a power failure.

K. The system requires a 440-volt power source.

L. The two point suspension is a desirable feature.

M. A 40-foot trailer is required to transport the system along with a 2½-ton cargo truck to tow the trailer mounted power supply.

N. It is not possible to calculate the rigging capacity of the aerial delivery company using the MDS-43.

7. **Recommendations.**

A. The MDS-43 Gantry Crane System should be modified to operate from a 220-volt power source.

B. A manual back-up system should be provided in the event of a power failure.

C. A similiar system in the range of 20,000 pounds should be developed since the majority of loads rigged are in this weight range.

/s/t/ JAMES D. ROLLINS
CW4, USA
Evaluation Project Officer

3 Inclosures
Dimensions of loads used in evaluation
Disassembly/Assembly time requirements
Dimensions of Gantry Crane System

DIMENSIONS OF EQUIPMENT USED IN EVALUATION

Item	Unrigged				Rigged			
	L	W	H	WT	L	W	H	WT
M-151 ¼-Ton Truck	133	64	71	2,400	134	108	72	3,088
Case 1150 Bulldozer	191	110	78	22,760	259	110	97	25,130
M-561 1¼-Ton Truck	227	84	70.5	7,300	240	108	94	8,920
645M Scoop Loader	279	101	92	25,200	327	108	99	29,650
M551 ARAAV	248	110	96.5	31,080	288	110	101.5	35,100
LAPES M-561 1¼-Ton Truck	227	84	70.5	7,300	244	108	86	9,800

Incl 1

DISASSEMBLY/ASSEMBLY TIME REQUIREMENTS

Disassembly:	35 minutes 4-man crew 1 forklift oper. 1 10K forklift
Loading: (and tie down)	1 hour 4-man crew 1 forklift oper. 1 10K forklift Approx 45 tiedown straps.
Unload:	17 min w/10K forklift
Assembly:	54 min 4-man crew 1 forklift oper 1 10K forklift

Incl 2

DIMENSIONS OF MDS-43 GANTRY CRANE SYSTEM

Lifting Legs (4 in system)
Length: 36.5 inches
Width: 29 inches
Height: 107 inches

Control Console
Length: 26.5 inches
Width: 19 inches
Height: 52.5 inches

Gantry (disassembled for shipment)
Length: 252 inches
Width: 97 inches
Height: 56 inches

Weight (all components listed above): approx 12,500 pounds

*Power Source
Length: 162 inches
Width: 92 inches
Height: 89 inches
Weight: 7,710 inches

* Government-owned standard 60-kW generator, trailer-mounted.

Incl 3

APPENDIX C

LETTER REPORT NUMBER 280

MILVAN JACKING SYSTEM TEST CONDUCTED AT THE HELFAST FIELD TEST SITE

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and
Bernard M. DaVall

June 1980

US ARMY HUMAN ENGINEERING LABORATORY

ACKNOWLEDGEMENT

The HELFAST team gratefully acknowledges the support and cooperation of: William Hellmann, Modular Distribution Systems of America and Eugene Rodrick, USAMERADCOM.

OTHER REPORTS PUBLISHED BY THE HELFAST TEAM ARE:

HEL Technical Note 3-30, "Use of Rough Terrain Forklifts for Night Ammunition Transfer Tasks"

HEL Letter Report, "Human Engineering Laboratory Test of Paperwork Processing Within the Ammunition Supply Point Office for Ammunition Issue."

HEL Letter Report, HELFAST Field Test of the 4000-Pound Rough Terrain Forklift."

MILVAN JACKING SYSTEM TEST CONDUCTED

AT THE HELFAST FIELD TEST SITE

Background.

In early 1980, the Missile and Munitions Center and School (MMCS) asked if the HELFAST Team could evaluate a MILVAN handling system that appeared to have possible use in the Corps Ammunition Supply Point (ASP) for low volume container handling requirements. Some testing had been conducted at Fort Bragg under Mobility Equipment Research and Development Command (MERADCOM) sponsorship but had not addressed human factors considerations. The Human Engineering Laboratory (HEL) agreed to evaluate the container jacking system in an ASP type environment and provide observations and comments on the human factors considerations of the system as an alternative method of mounting/dismounting MILVAN containers. Presently there is no such capability in the TO&E of the ASP's ammunition company and the anticipated frequency of need does not justify inclusion of more costly container handling equipment. In addition, having the capability to ground a loaded MILVAN before unstuffing it has two advantages: (a) the transporter can be released immediately, (b) the 4000-lb Rough Terrain Forklift (RTFL) required to unstuff the MILVAN does not have to use the 35-foot mobile ramp.

Note: In previous testing of the 4000-lb RTFL, the HELFAST Team had determined that 1.5 minutes were required for each lift if the MILVAN being unstuffed was grounded. However, 2.5 minutes per lift were required if the MILVAN was still mounted on its transporter and the RTFL had to use the 35-foot ramp. Thus, grounding the MILVAN will reduce the unstuffing time by 40 percent. (See HEL Letter Report 279, "HELFAST Field Test of the 4000-Pound Rough Terrain Forklift.")

Perspective.

The HELFAST Team of the Human Engineering Laboratory has been testing Materials Handling Equipment used in ammunition supply for the past three years. This testing has been at a field test site that closely resembles an area that would be selected for a combat Ammunition Supply Point (ASP). Therefore, all the equipment tested, to include the MILVAN Jacking System, was evaluated in as realistic an operational environment as possible. The observations and recommendations included in this report are included only to summarize the test team's observations and are not intended to indicate either shortcomings or deficiencies as defined by AR 310-25.

Testing.

The MILVAN jacking system, provided by the Modular Distribution Systems of America, was obtained from Fort Belvoir in May 1980, and was tested on concrete hardstand and an unimproved field locations. The system was operated on both level and sloping surfaces as well as a slightly ditched (8-inches) unimproved single lane dirt roadway. All tests were started and ended with the system components placed in a typical open storage configuration. Although the system is capable of being transported in any vehicle with cargo capacity similar to a 5-ton cargo truck, the transportation and loading/unloading of the system was not a part of this test. The 6000-lb capacity rough terrain forklift (RTFL) presently included in the ammunition company TO&E was used to handle the systems jacking legs. In each test, incremental and elapsed times were recorded for each separate step in the system operation.

The times shown below, for typical ASP requirements, are average times obtained from repeated tests and are considered to be valid planning times for semi-trained operators. Note that two personnel were used to operate the system, one to operate the 6000-lb RTFL and the second to operate the generator and jacking system. (The tractor/trailer driver was not used for any purpose but driving and has no effect on the data.)

Dismount MILVAN		Mount MILVAN	
Activity	Elapsed Time (min:sec)	Activity	Elapsed Time (min:sec)
Start (All gear grounded)	0:00	Start (All gear grounded)	0:00
Affix legs	10:00	Affix legs	10:00
Raise MILVAN	12:30	Raise MILVAN	12:00
Remove carrier	13:00	Position carrier	13:00
Lower MILVAN to ground	14:00	Attach MILVAN	15:30*
Stow entire system	24:00	Remove 4 legs	25:00
		Stow entire system	27:00

*Note: Attaching MILVAN included alignment of Hold Downs that were up to 6 inches out of alignment in both directions.

An attempt was made to operate the system using the 5-ton truck mounted crane (ROPCO) in place of the 6000-lb RTFL. Although the system can be operated using the crane, it is much more difficult to attach or remove the legs because of the longer times required for crane operation and the difficulty in precise movement of the crane. A complete operation was not attempted. After removal of two legs from the MILVAN the test was stopped as it became apparent that time would not be competitive with those obtained using the 6000-lb RTFL. With two personnel operating the system using a crane would at least double the time required using the 6000-lb RTFL.

Using a 6000-lb RTFL with the system, the time dependent component of the operation is the electrical hook-up of the system. With a crane, mounting or dismounting the legs becomes the time dependent component of the operation.

No night testing was conducted as the system is simple enough that a flashlight would provide sufficient light for the relatively few elements of the operation that would require illumination at levels above that of ambient light.

Observations and Recommendations.

(1) The ground support stools on the lifting posts are adequate for hard-stand storage but would be better suited to unimproved terrain if the feet had larger ground pads (see Photo Item 1 in Appendix).

(2) The safety latch for the top locking device is designed differently from the lower lock safety latch and is difficult to operate, particularly when wearing gloves (see Photo Item 2 in Appendix).

(3) The drums, for the two long cables running to the farther legs appear to be of marginal value. It would be more efficient to hard-wire the cables at the control console and key the receptacles on each leg to accept only the correct cable (see Photo Item 3 in Appendix).

(4) Electrical control console would be easier to handle if provided with fork slots compatible with the 6000-lb RTFL (see Photo Item 4 in Appendix).

(5) The separate foot plates for the jacking legs have a raised containment feature which occasionally interferes with their use when the MILVAN is grounded on soft terrain. A simple flat plate would be more suitable in marginal terrain (see Photo Item 5 in Appendix).

(6) The separate foot plates are presently stored on the side of the jacking leg. When the system is used to remove a MILVAN from a trailer, if the plates are not removed before the legs are attached to the MILVAN, the height of the stowed plates makes it difficult to remove them for use. Stowing the plates in or on the ground support stools would make them more accessible (see Photo Item 6 in Appendix).

(7) At present, electrical connections to the jacking legs are through manually locked electrical connectors. A spring-loaded self-locking protective cover would be more effective for both connector locking and connector protection (see Photo Item 7 in Appendix).

(8) The present cable restraint devices on the jacking legs would probably be ineffective in extreme cold weather or icing conditions (see Photo Item 8 in Appendix).

(9) Warning/advice lights on the control console are difficult to see in bright sunlight. Hooded or recessed tube lights would probably be more effective (see Photo Item 9 in Appendix).

(10) The extensible legs of the jacking posts are unpainted and therefore are a dark metallic color. Visibility of the legs is important when backing a trailer under the raised MILVAN, particularly at night. Painting the extensible portion a lime yellow would make it much more visible in both day and night operations (see Photo Item 10 in Appendix).

(11) Observations 1 and 6 above might be resolved most effectively by making a large stool support plate which is demountable for use either on the stool or under the jacking leg.

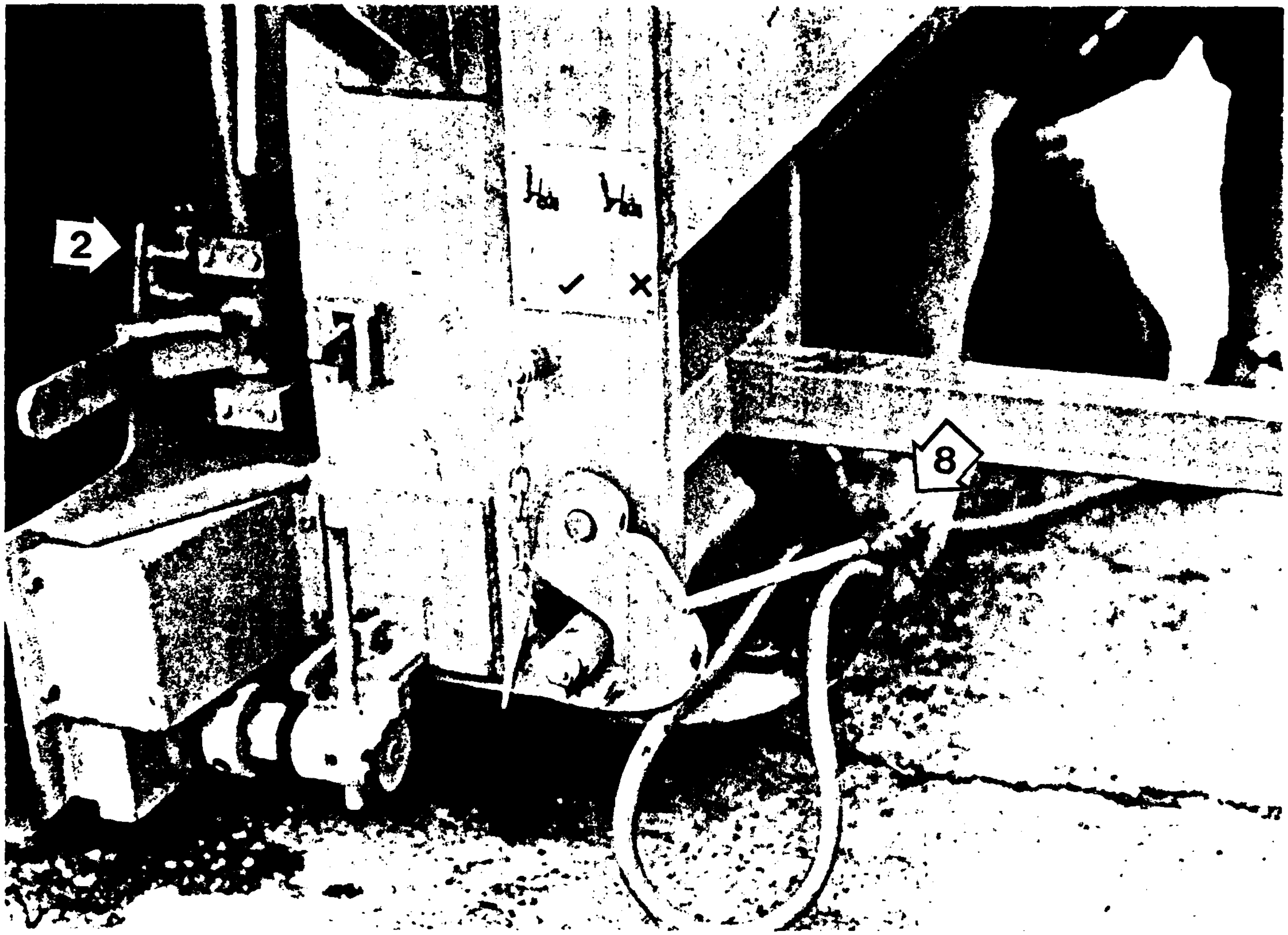
(12) The jacking system is well safety engineered in that fail-safe electrical and hydraulic features have been incorporated, there are no sharp edges or corners presented, and both audio and visual warnings are incorporated to indicate faults or incipient problems such as load out of level.

(13) The simplistic operation of the system does not require lengthy training to become a safe and efficient operator, nor does it require great size, strength, or weight on the part of the operator.

Summary.

The MILVAN jacking system performed well in each test conducted, with no malfunctions and with completely satisfactory results. The system appears to be well suited for low volume container grounding or mounting. It is flexible enough to accommodate reasonable uneven ground, misalignment of semi-trailer or carrier in any direction up to at least six inches and can withstand safely a minor collision with the supporting legs. The system appears to be suitable for military adoption although logistical support requirements would be simpler with military standard electrical connectors and S.A.E. hardware.

Attachment of power cable to lifting leg.

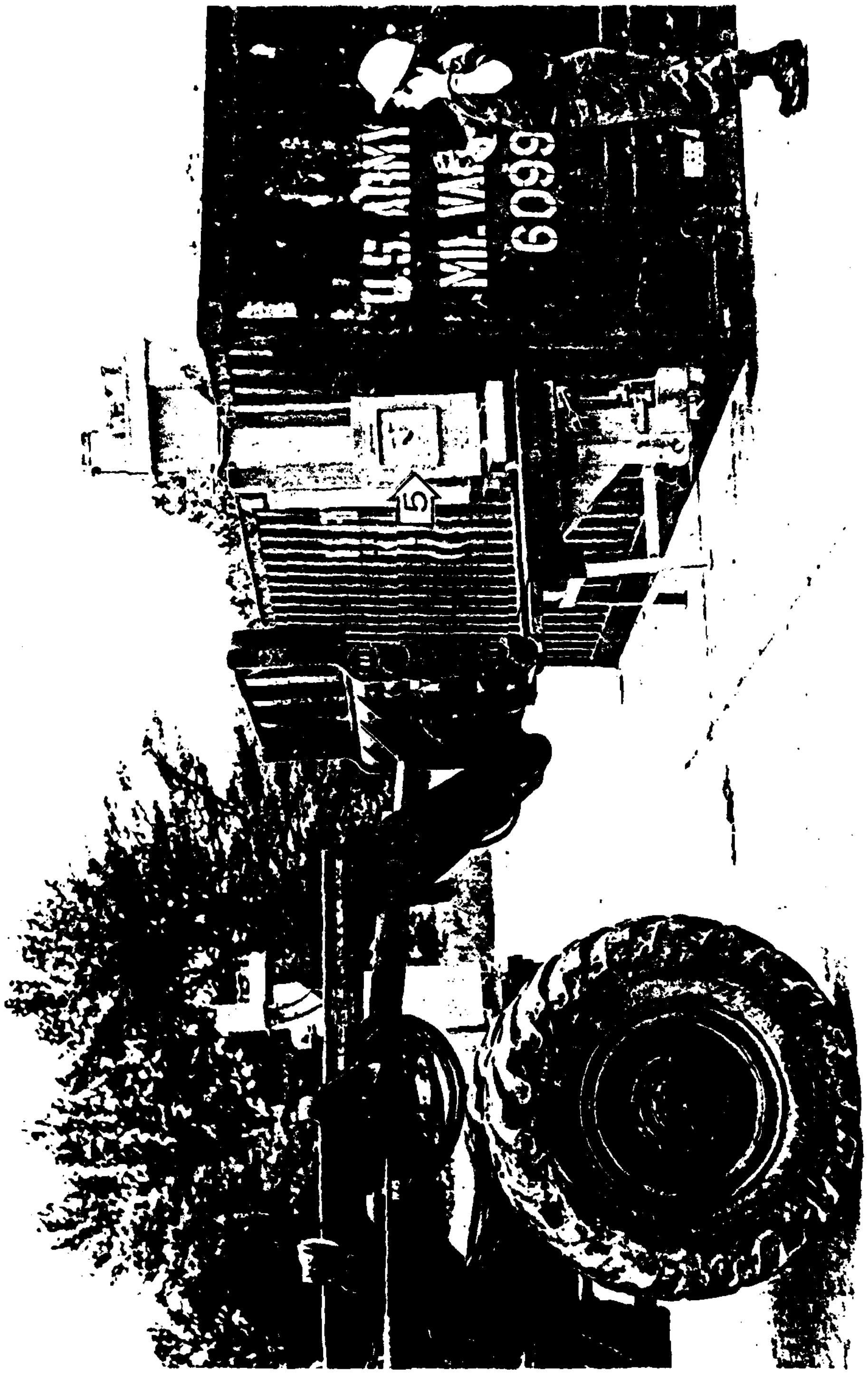


Upper and lower locking devices.

Securing power cable to lifting leg.

Control console.

Operators control.

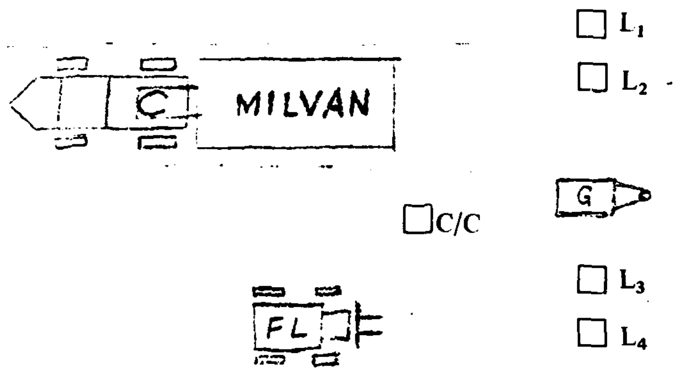


Attaching lifting legs using the 6000-lb RTFL.

MILVAN raised, ready for emplacement.

HELFAST JACKING SYSTEM TEST

Starting/Ending Position



FL = 6000 # RTFL   G = TRL MTD MIL GENERATOR

C/C = CONTROL CONSOLE L_1, L_2, L_3, L_4 = JACKING LEGS

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